

## The Metabolic Cost of a High Intensity Exercise Program during Bed Rest

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**Background:** Given that disuse-related skeletal muscle atrophy may be exacerbated by an imbalance between energy intake and output, the amount of energy required to complete exercise countermeasures is an important consideration in the well being of subject health during bed rest and spaceflight.

**Objective:** To evaluate the energy cost of a high intensity exercise program performed during short duration bed rest.

**Methods:** 9 subjects (8 male and 1 female;  $34.5 \pm 8.2$  years) underwent 14 days of bed rest and exercise countermeasures. Exercise energy expenditure and excess post exercise oxygen consumption (EPOC) were collected once in each of 5 different exercise protocols (30 second, 2 minute and 4 minute intervals, continuous aerobic and a variety of resistance exercises) during bed rest. Body mass, basal metabolic rate (BMR), upper and lower leg muscle, subcutaneous, and intramuscular adipose tissue (IMAT) volumes were assessed before and at the end of bed rest.

**Results:** There were no significant differences in body mass (pre:  $75.1 \pm 10.5$  kg; post:  $75.2 \pm 10.1$  kg), BMR (pre:  $1649 \pm 216$  kcal; post:  $1657 \pm 177$  kcal), muscle subcutaneous, or IMAT volumes (Table 2) after 14 days of bed rest and exercise. Body mass was maintained with an average daily intake of  $2710 \pm 262$  kcal ( $36.2 \pm 2.1$  kcal/kg/day), while average daily energy expenditure was  $2579 \pm 311$  kcal ( $34.5 \pm 3.6$  kcal/kg/day). Exercise energy expenditure was significantly greater as a result of continuous aerobic exercise than all other exercise protocols.

**Table 2.** Compartment volumes before and after 14 days of bedrest (means  $\pm$ SD).

|                                     | Upper Leg      |                | Lower Leg     |               | Total          |                |
|-------------------------------------|----------------|----------------|---------------|---------------|----------------|----------------|
|                                     | Pre            | Post           | Pre           | Post          | Pre            | Post           |
| Subcutaneous AT† (cm <sup>3</sup> ) | 425 $\pm$ 322  | 447 $\pm$ 309  | 117 $\pm$ 121 | 121 $\pm$ 92  | 542 $\pm$ 405  | 568 $\pm$ 387  |
| Intramuscular AT†(cm <sup>3</sup> ) | 117 $\pm$ 29   | 117 $\pm$ 28   | 90 $\pm$ 50   | 84 $\pm$ 44   | 207 $\pm$ 75   | 201 $\pm$ 66   |
| Skeletal muscle (cm <sup>3</sup> )  | 1757 $\pm$ 222 | 1771 $\pm$ 240 | 622 $\pm$ 195 | 628 $\pm$ 202 | 2379 $\pm$ 318 | 2399 $\pm$ 336 |

†Adipose Tissue; n=8.

**Conclusions:** In addition to exercise countermeasures, careful dietary monitoring and consumption of at least 36 kcal/kg/day may be required to attenuate disuse-induced muscle atrophy.